Bowling Green, Kentucky
An Example of the Challenges of Developing on Karst

Lost River Cave

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Bowling Green, Kentucky

Environmental Show of the South
Chattanooga
17 May 2018

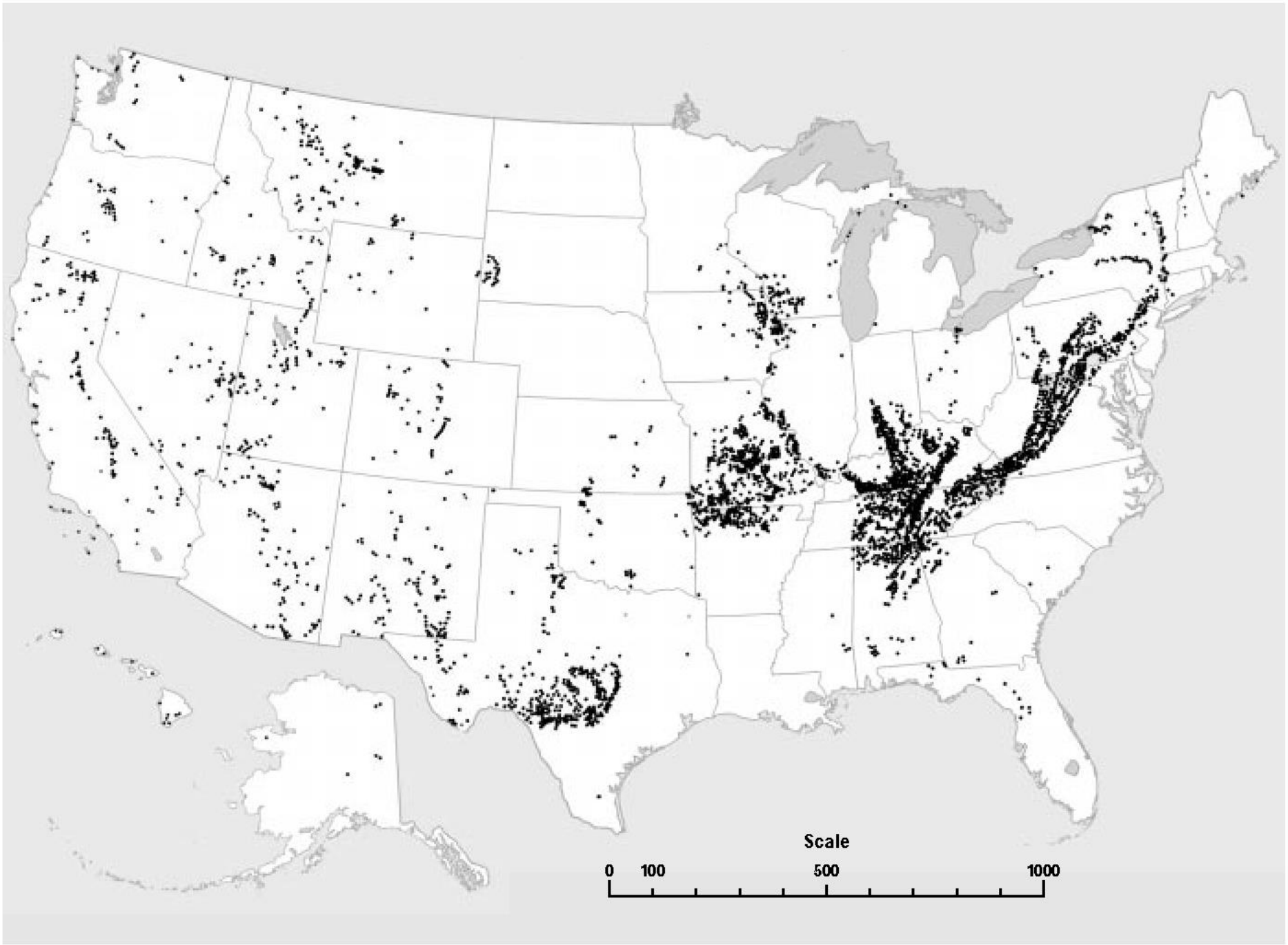
OUTLINE

- **Bowling Green, Kentucky**
  - **Background**
- **Challenges of Developing on Karst**
  - **Sinkhole Collapse**
  - **Flooding**
  - **Pollution**
- **Regulatory Measures**
- **Prominent Local Karst Features**

Bowling Green, Kentucky

- Founded 1798
- 38.5 Square Miles (99.7 Square Kilometers)
- Located on the Karst Sinkhole Plain of South Central Kentucky
  - Mississippian Limestone's
- 2016 Population
  - City 65,234
  - Warren County 122,851
- Home Of
  - Western Kentucky University
  - Lost River Cave
  - The Corvette

Hibbs Hole



Adapted from the *National Atlas*, U.S. Geological Survey, 1970.

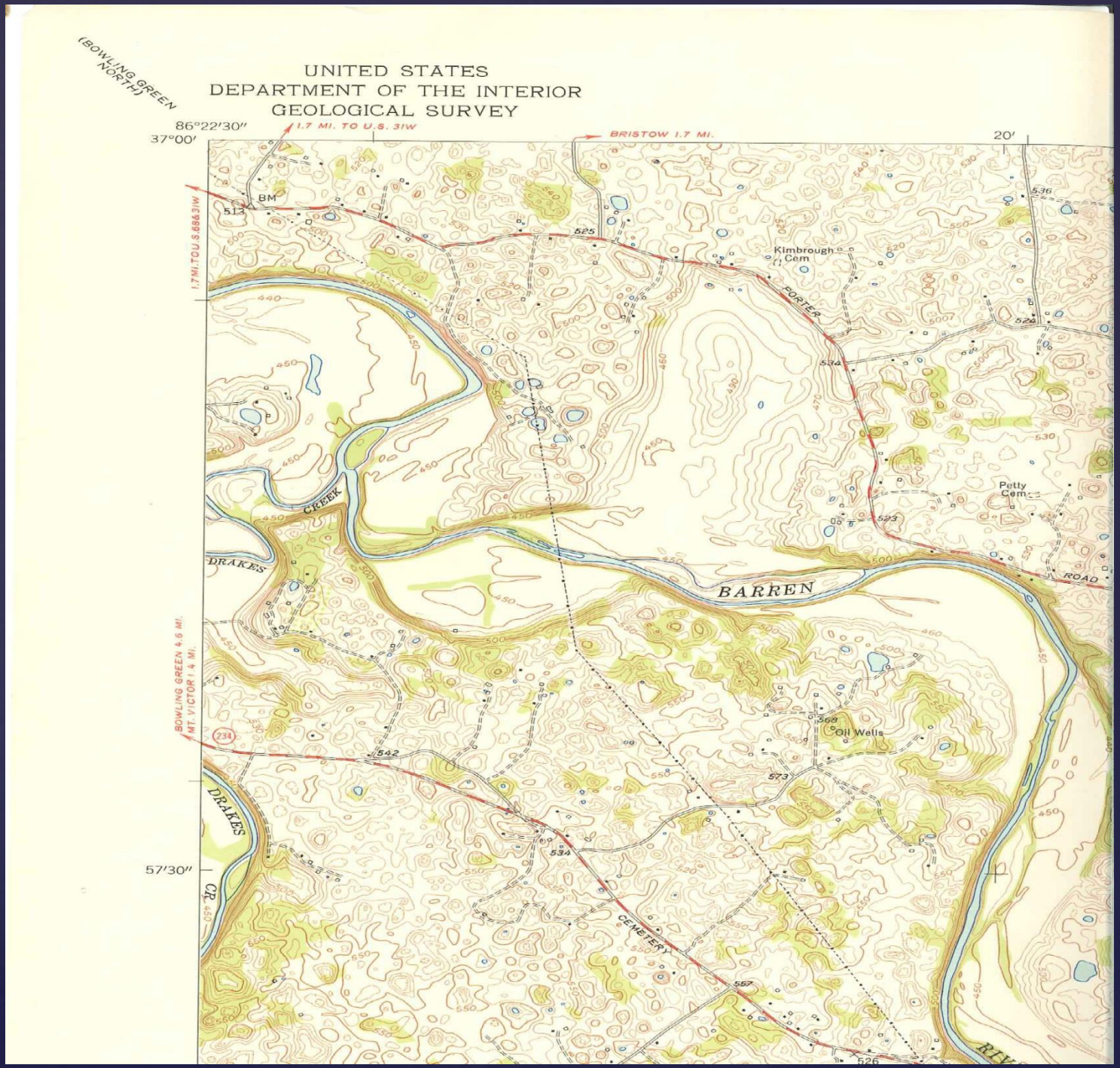
Challenges of Developing on Karst

Sinkhole Collapse

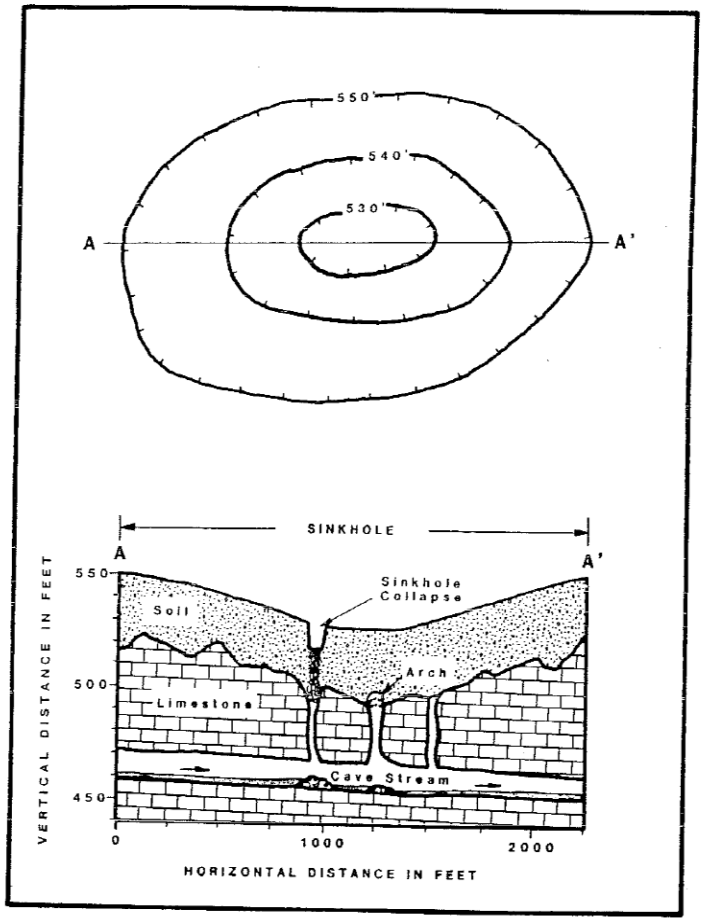
Cemetery Road

Sinkhole

- Prominent feature on the Karst Sinkhole Plain
- Closed surface depressions
- Range from a few meters across to a kilometer or more
- Range from a few meters to hundreds of meters deep
- Runoff drains thru the bottom, to the underlying limestone, then carried to springs via cave streams
- Bowling Green built entirely on the Sinkhole Plain


(BOWLING GREEN NORTH)
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
86°22'30"
37°00'
20'
57'30"
1.7 MI. TO U.S. 31W
BRISTOW 1.7 MI.
1.7 MI. TO U.S. 68&31W
BOWLING GREEN 4.6 MI.
MT. VICTOR 1.4 MI.
BM
513
525
536
Kimbrough Cem
PORTER
524
534
530
Petty Cem
523
ROAD
CREEK
DRAKES
BARREN
568
Oil Wells
542
573
DRAKES
CR.
534
CEMETERY
557
526

PLAN AND PROFILE VIEW OF A TYPICAL SINKHOLE ON THE PENNYROYAL SINKHOLE PLAIN OF WARREN COUNTY



Sinkhole Collapse

- Nearly all are regolith collapses (bedrock collapses rare)

- 70% of Warren County collapses caused by farming activities or urban development

- Increased runoff to small areas greatly increases risk of collapse

- Major contributors:
  - Poor drainage well construction
  - Surface ponding and concentration
  - Leaking pipes

Sinkhole Collapse,
Drain Well at Jones-Jaggers School

Sinkhole Collapse, Magna Pond

Sinkhole Collapse, Dishman Lane

Challenges of Developing on Karst

Flooding

Barren River

Flooding on Karst

- Occurs Naturally
- Usually High Intensity, Short Duration
- Runoff Exceeds Capacity of Underlying Caves
- No Floodplain, Excess Stored in Sinkholes
- Surface Streams at Flood Stage Create Backwater Effect
- Early Development Built in Sinkholes
- Worst Flooding in Large, Shallow Sinkholes with Large Catchment Areas

1, 2 May 2010

10 Inches (24.5 Centimeters) Fell in 48 Hours

Barren River

Normal Base Flow for Barren River is 1500 CFS, During May 2010 Flood, peak flow was 56,900 CFS on 3 May 2010

Lansdale Avenue

Natural Storm Sewer

- Caves Under BG used Since City Founded
- City Directs Runoff to Caves
- Limited Capacity
- Minimal Traditional Storm Sewers
- Storm Water Drainage Wells

By-Pass Cave

Storm Water Drainage Wells

- Primary Deliver Method of Storm Water to Caves
- Over 1,000 Drilled in Bowling Green and Warren County
- Drill Until Cave, Void or Fracture Encountered that Takes Water
- No Other City has More
- Bowling Green has Own Drill Rig
- Must Be Maintained

Emmett Avenue

Cave Mill Road

WKU

Challenges of Developing on Karst

Pollution


FLAMMABLE
CUYAHOGA
RIVER

Water Pollution ~ Past Issues

BGMU Sewer Outfall on Barren River

24 March 2004

Point Source

- Single Identifiable Source
- Industrial
- Sewage Treatment

Most Point Sources Have Been Permitted in the Last 40+ Years

Water Pollution ~ Today

Nonpoint Sources

- Contamination Carried Into Water by Storm Water Runoff
- Contributed by Entire Watershed (Geographic, Not Political Boundaries)
- Contamination Sources
  - Impervious Surfaces
  - Buildings
  - Farmland
  - Construction Sites
  - Septic Systems, Straight Pipes

Popular Mechanics,

May 1921

"SEWER SYSTEM MORE THAN A MILLION YEARS OLD"

By Charles E. Mace

Popular Mechanics Magazine, Vol 35, No. 5, May 1921, pp. 687-688.

The only city in the United States boasting a sewer system to which all the "pipes" were laid by Mother Nature is Bowling Green, KY. Although the prosperous little municipality has a population of 15,000 there is not a foot of man-made sewer pipe in any of the streets or alleys.

The explanation is that the city is built over a formation of oölitic white limestone which is a maze of connected crevices extending to a considerable depth below the surface: much the same formation as that of the famous Mammoth Cave just 30 miles distant. This limestone is said to be composed of the fossilized eggs of prehistoric marine animals. The "logs" of oil wells drilled in the western Kentucky fields, of which Bowling Green is the center, show that limestone of one kind or another is encountered as deep as drilling has ever yet been carried.

When a new residence is being built in the Bowling Green region, a "sink finder" is employed, who merely goes out in the back yard and digs about in the surface soil, which is seldom more than 3 ft. deep, until he locates a fissure. A garden hose is then placed in the crevice, and the water is allowed to run until it is free from obstructions. It is then approved by the city inspector, and the house has perfect sewer connection. No city has a more sanitary system. Chemists say the sewage would be purified in a very short distance by passing through the limestone. Seepage never comes to the surface, the explanation of the geologists being that it flows through these natural passageways in the stone until it finally finds an outlet in the river bed.

An interesting character is found in "Uncle" Henry Jameson, an aged negro who has specialized in locating fissures and digging "sinks" for the past 25 years. When asked just how many he had dug, he laughed and said "Lawdy, Boss, I reckon I couldn't count that many." Uncle Henry uses the divining rod, or "witch stick," as he calls it, in locating the fissures, and declares he would never dig without first employing his forked peach-tree branch. The frequency with which his attempts are successful is amazing. Although Henry is 74 years of age, his services in this capacity are in such demand that the builders will not let him retire, and he has just signed a contract to locate sinks for 25 new residences now under construction in the city.

A syndicate of oil operators who are wont to bank on superstition rather than geology, recently sought to employ Uncle Henry to locate sites for oil wells, but he declined, saying that it was not the oil or water that attracted the forked twig but the crevices in the limestone.

It is fortunate for Bowling Green that nature has provided this elaborate and efficient scheme. When one considers that the surface soil is not sufficiently deep in many places to bury the sewer pipes, it is obvious that the expense of digging trenches in the usual way would be prohibitive.

"Uncle" Henry Jameson, Aged negro specialist, with the Divining Rod, or "Witch Stick"; He uses this peach-tree fork to locate a crevice in the underground formation.

Outcropping of Oölitic Limestone in Bowling Green's City Park, which shows very clearly the cavernous structure of this formation which underlies the entire city, hidden for the most part by a light covering of surface soil.

Once a fissure in the limestone is found, it is tested with a hose to prove it free from obstructions, then approved by the Inspector, and the house has sewer connection.


2008/04/28

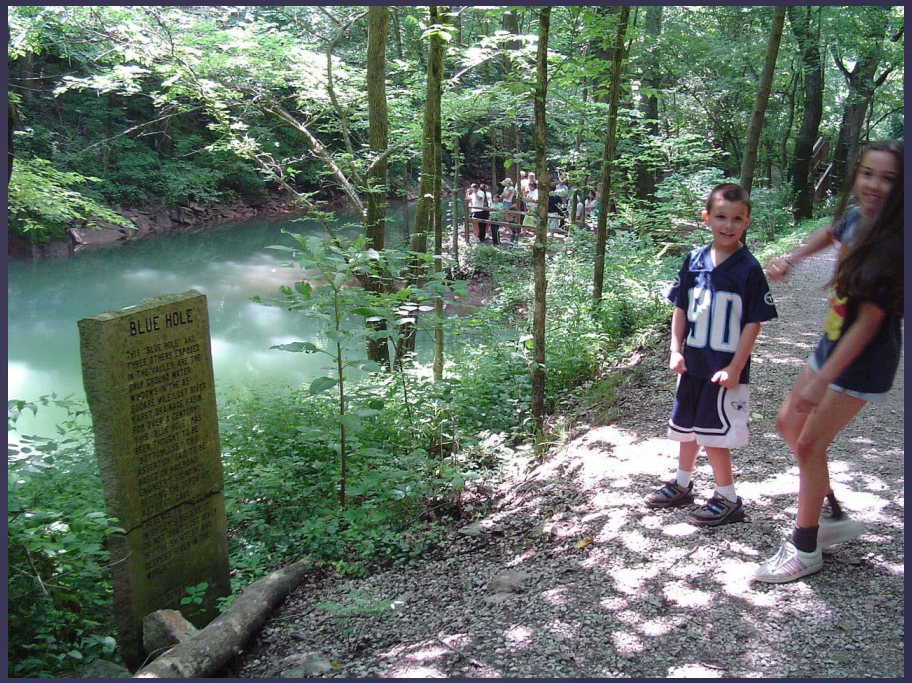

CASE
2009/03/01

Use of Flouescent Dyes To Map Groundwater Basins

Logan Way Dye Trace

Real Time Monitoring Stations

Underbgky.org



Lost River Bluehole

Lost River Rise

Regulatory Measures

Background

1972 Clean Water Act

- Point Sources
- Prohibited Pollutant Discharge Unless Permitted
- National Pollutant Discharge Elimination System (NPDES)

1987 Amendments to Clean Water Act

- Non-Point Sources
- Phase I Communities, 16 November 1990
- Phase II Communities, 10 March 2003

City of Bowling Green Phase II Program

The 6 Control Measures

1 - Public Education
2 - Public Involvement
3 - Illicit Discharge Detection and Elimination
4 - Construction Site Regulation
5 - Post Construction
6 - In House Operations (Good Housekeeping)

Public Education

Public Involvement

Illicit Discharge Detection and Elimination

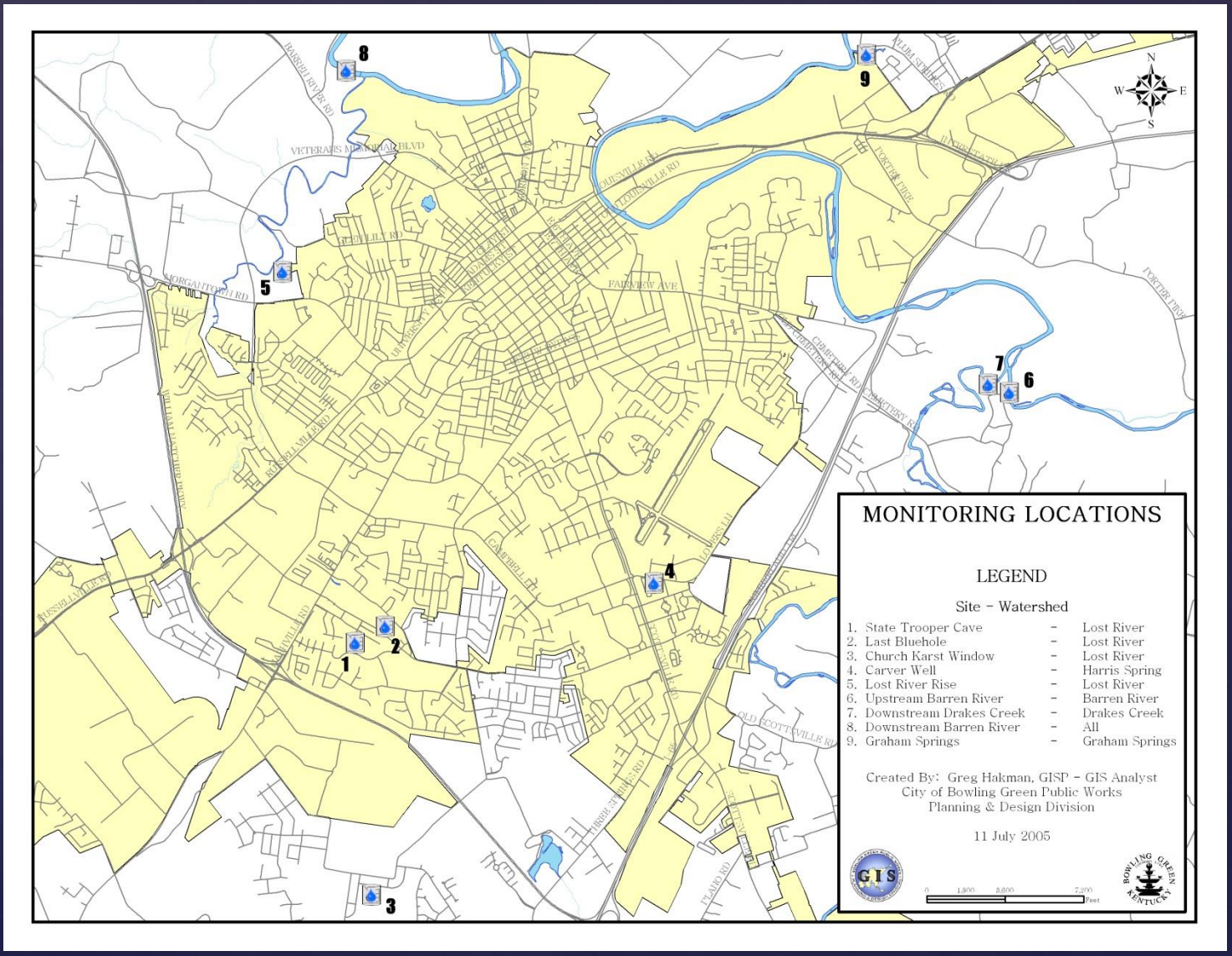
Free Household Hazardous Waste Disposal Day

Construction Site Regulation

Post Construction

In House Operations (Good Housekeeping)

Quarterly Monitoring Program
Since January 2005



Local Karst Features

Church Karst Window

State Trooper Cave

Mt. Ayr Bluehole

Spring Feeding a Bluehole in Lost River Cave Valley

Dam at Entrance to Lost River Cave

Questions?